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PATENT ABSTRACTS OF JAPAN

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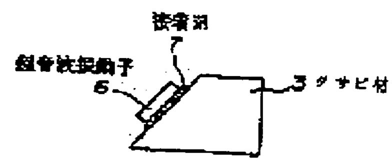
(54) ULTRASONIC FLOWMETER

(57)Abstract:
PURPOSE: To relieve the thermal stress generated between a vibrator and wedge member so as to improve the propagation rate of acoustic waves to the wedge member.
CONSTITUTION: In the ultrasonic flowmeter which measures the flow velocity or flow rate of a fluid from the difference between the propagation time of acoustic waves from an ultrasonic vibrator on the upstream side to another ultrasonic vibrator on the downstream side and the propagation time of acoustic waves in the opposite direction, a filler is mixed in the adhesive 7 used for sticking the ultrasonic vibrators 6 to wedge members 3 so as to achieve the above-mentioned purpose.



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CLAIMS

[Claim(s)]

[Claim 1] An acoustic wave is made to spread with a certain fixed placing include angle for the inside of piping through wedge material to the flow of flowing fluid. In the ultrasonic flowmeter which measures the rate of flow or flow rate of a fluid from the difference of the travelling period of the acoustic wave from an upstream ultrasonic vibrator to a down-stream ultrasonic vibrator, and the travelling period of the acoustic wave from a down-stream ultrasonic vibrator to an upstream ultrasonic vibrator The ultrasonic flowmeter characterized by mixing a filler in the adhesives for pasting up said ultrasonic vibrator and wedge material.

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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Industrial Application] This invention relates to the so-called ultrasonic flowmeter which measured the rate of flow or flow rate of a fluid from the travelling period difference of a supersonic wave at the time of making an acoustic wave spread aslant to the flow of a fluid.
[0002]
[Description of the Prior Art] Drawing 6 is an explanatory view for explaining the measurement principle of a transparency mold ultrasonic flowmeter. First, if the upstream ultrasonic vibrator 1 is excited with a supersonic wave, the supersonic wave by which outgoing radiation was carried out will be spread to the oblique angle wedge 3. This oblique angle wedge 3 carries out incidence of the supersonic wave aslant to the flow 5 of a fluid. Furthermore, although a supersonic wave is spread from piping 4 to the flow 5 in piping, in each interface with the flow 5 in the oblique angle wedge 3, piping 4 and piping 4, and piping, an acoustic wave is refracted according to the **** Snell's law shown in drawing 7 . In addition, in i of drawing 7 , and o, a medium, thetai, and thetao show Co and an incident angle, a reflective (outgoing radiation) angle, and Ci show the acoustic velocity in Media i and o, respectively.
[0003] The acoustic wave spread to the flow 5 in piping reaches an opposed face, and after it is refracted again in an interface (a fluid, piping and piping, and wedge), it is received by the down-stream ultrasonic vibrator 2. When the travelling period of an acoustic wave until it reaches a down-stream ultrasonic sensor from a besides style is set to T12 and a travelling period in case the down-stream ultrasonic vibrator 2 is excited conversely and the upstream ultrasonic vibrator 1 receives an acoustic wave is set to T21, each travelling period is expressed with (following 1) and following (2) types. In addition, in the travelling period in piping and an oblique angle wedge, and D, the bore of piping and C show the acoustic velocity of a fluid, and V shows [tau] the rate of flow of a fluid, respectively.

$$T12 = 2\tau + \frac{2D/\cos\theta}{C + V \cdot \sin\theta} \quad \cdots (1)$$

$$T21 = 2\tau + \frac{2D/\cos\theta}{C - V \cdot \sin\theta} \quad \cdots (2)$$

[0004] When there is the rate of flow so that clearly also from an upper type, it turns out that time difference arises in T12 and T21 (when V is not zero). Generally this ultrasonic flowmeter is broadly used from the ability of the rate of flow in piping whose bore is 25mm - 3000mm, and a flow rate to be measured. By the way, resin with a moderate acoustic wave attenuation factor from which the multiple echo in the interior does not pose a problem as an ingredient of an oblique angle wedge is used, and, generally the resin of an acrylic and an epoxy system is used. In 80 degrees C and epoxy, the heat-resistant temperature of these resin is near 120 degree C from acrylics, and implementation of an elevated-temperature highly precise flowmeter 200

degrees C or more was made impossible. However, various kinds of heat-resistant engineering plastics (henceforth engineering plastics) were commercialized, and the problem was lost to the thermal resistance as wedge material recently. However, the new problem that both destroy has arisen by the difference of coefficient of linear expansion with vibrator and engineering plastics.

[0005]

[Problem(s) to be Solved by the Invention] that is, -- the case where an operational temperature range reaches far and wide -- a trembler, adhesives, and wedge material -- thermal stress is produced from a difference of each coefficient of linear expansion, and there is a problem of causing destruction of each part material. moreover, adhesives -- Pure (pure) -- when it is only resin, the problem that it is large and the acoustic wave from a trembler does not fully spread to wedge material also has the difference of the acoustic impedance of a trembler and adhesives. Therefore, the technical problem of this invention is to raise the rate of propagation of the acoustic wave to wedge material while easing the thermal stress generated between a trembler and wedge material.

[0006]

[Means for Solving the Problem] In order to solve this technical problem, an acoustic wave is made to spread in this invention with a certain fixed placing include angle for the inside of piping through wedge material to the flow of flowing fluid. In the ultrasonic flowmeter which measures the rate of flow or flow rate of a fluid from the difference of the travelling period of the acoustic wave from an upstream ultrasonic vibrator to a down-stream ultrasonic vibrator, and the travelling period of the acoustic wave from a down-stream ultrasonic vibrator to an upstream ultrasonic vibrator It is characterized by mixing a filler in the adhesives for pasting up said ultrasonic vibrator and wedge material.

[0007]

[Function] By mixing a filler in the adhesives for pasting up an ultrasonic vibrator and wedge material, the coefficient of linear expansion as the whole adhesives becomes small. Thereby, a trembler, adhesives, and the thermal stress between wedge material are eased. Moreover, since a consistency becomes large and also increases a degree of hardness, attenuation of a supersonic wave also becomes small.

[0008]

[Example] Drawing 1 is the block diagram showing one example of this invention. This drawing shows the relation between an ultrasonic vibrator 6, adhesives 7, and the wedge material (oblique angle wedge) 3, and shows the ultrasonic sensor which attached vibrator 6 with adhesives 7 and constituted it on the top face of the oblique angle wedge 3. That is, although the configuration itself [such] is well-known, since the coefficient of linear expansion of engineering plastics is large about single figure compared with vibrator, in order to use the engineering plastics of a polyimide system for the oblique angle wedge 3 here at vibrator 6 using the piezoelectric device like PZT [Pb(Zr-Ti) O3], and to ease the difference of the both coefficient of linear expansion, it is characterized by the point which filled up the adhesives of a polyimide system with spherical fused silica. And he is trying to lose bad influences, such as dispersion of a supersonic wave, and refraction, by considering as the impalpable powder of a real ball-like silica by an average of 0.5 micrometers, and considering as 1/10 or less value of the wavelength of the supersonic wave (1MHz) to be used as the magnitude as spherical fused silica, and making a configuration into a globular form.

[0009] Next, when a bulking agent is mixed in resin, relation like (3) and (4) types is materialized, using [phi] nu as a Poisson's ratio for a volume fraction (1 of phi1 and phi2 shows adhesives, and 2 shows a filler, and suppose that it is the same as that of the following.), and B by using a bulk-modulus and G into a modulus of transverse elasticity between coefficient of linear expansion alpha and modulus of direct elasticity E.

$$\alpha=\alpha 1\phi 1+\alpha 2\phi 2-(\alpha 1-\alpha 2)\phi 1\phi 2 \times \frac{1/B1-1/B2}{\phi 1/B2+\phi 2/B1+3/4G1} \quad \cdots (3)$$

$$E=\frac{1+AB\phi 2}{1-B\psi\phi 2}$$

ただし、$A=\frac{7-5\nu 1}{8-10\nu 1}$, $\psi=1+\frac{(1-\phi m)\phi 2}{\phi m^2}$

$$B=\frac{E2/E1-1}{E2/E1+A} \quad \cdots (4)$$

[0010] Drawing 2 shows change of the coefficient of linear expansion alpha and the modulus of direct elasticity E when changing the volume fraction phi 2 of a filler to 0 - 90% according to the above (3) and (4) types. Although the coefficient of linear expansion alpha shown as a continuous line will become small if a fill is made [many] so that clearly from this drawing, gradually, the modulus of direct elasticity E shown by the dotted line becomes large, and goes. Moreover, drawing 3 shows the thermal stress calculated based on alpha and E of drawing 2 . The example at the time of pasting up the trembler 6 of a disk mold as shown in drawing 4 as a computation model in this case on the sufficiently big wedge material 3 with adhesives 7 is assumed. Although the thermal stress of a trembler will decline and go if the fill of a silica is increased so that drawing 3 may also show, the thermal stress of adhesives and wedge material is rising. Since the resin of the same polyimide system was used for wedge material with adhesives while the thermal stress of a trembler was eased by the fall of the coefficient of linear expansion of adhesives, this is considered because the difference of coefficient of linear expansion becomes rather large by silica restoration. In addition, the continuous line of drawing 3 shows a trembler and, as for the dotted line, adhesives and an one-point slash show the case of the wedge material 3, respectively. Moreover, the drawing 4 (**) is a side elevation in which the side elevation and (Ha) show the result which carried out thermal expansion as for the plan of an ultrasonic sensor, and ** (**).

[0011] An example of the physical-properties value of the adhesives used in the example of this invention and a filler is shown in Table 1.

表 1

	接着剤	充填材
線膨張率〔 /℃〕	$\alpha 1=44.3\times10^{-6}$	$\alpha 2=0.5\times10^{-6}$
体積分率	$\phi 1=1$	$\phi 2=0\sim0.90$
体積緯線率〔$\times10^{9}$Pa〕	B1=5.02	B2=37.00
横弾性率 〔$\times10^{9}$Pa〕	G1=5.02	——
縦弾性率 〔$\times10^{9}$Pa〕	E1=5.02	E2=73.00
ポアソン比	$\nu 1=0.35$	——
最大充填分率	——	ϕm=0.9

[0012] Drawing 5 shows the situation of acoustic-impedance change of the adhesives by the fill of a silica. Since a consistency is large and a silica is hard compared with adhesives, by increasing a fill shows that an acoustic impedance changes a lot. Although an acoustic feature will become good if the fill of a silica is increased from the above consideration, about thermal stress, it cannot generally be said that it is good. Therefore, it is necessary to consider both balance according to a use application, and to decide a fill.
[0013]
[Effect of the Invention] Since it was made to make that coefficient of linear expansion by mixing a filler in adhesives into the in-between value of an ultrasonic vibrator and engineering plastics according to this invention, the thermal stress generated on the boundary of vibrator and adhesives can be eased. Furthermore, since the acoustic impedance of adhesives becomes large, the advantage it becomes possible whose to raise the rate of propagation of a supersonic wave is acquired.

[Translation done.]

* NOTICES *

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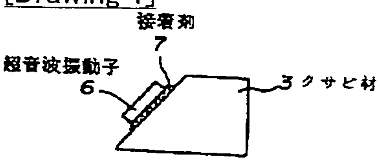
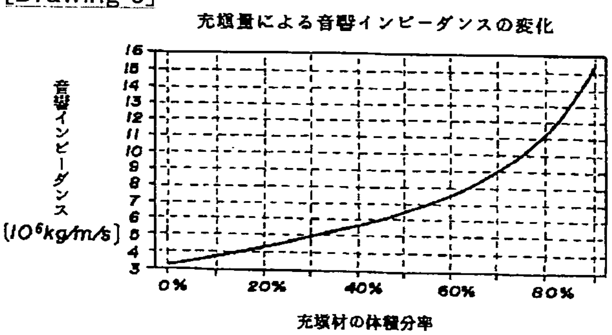
1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

DRAWINGS

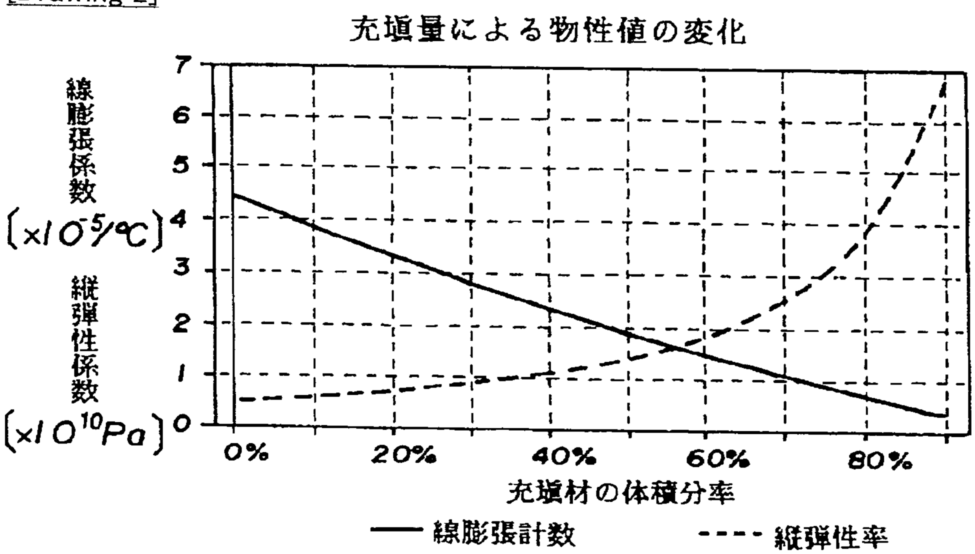
[Drawing 1]



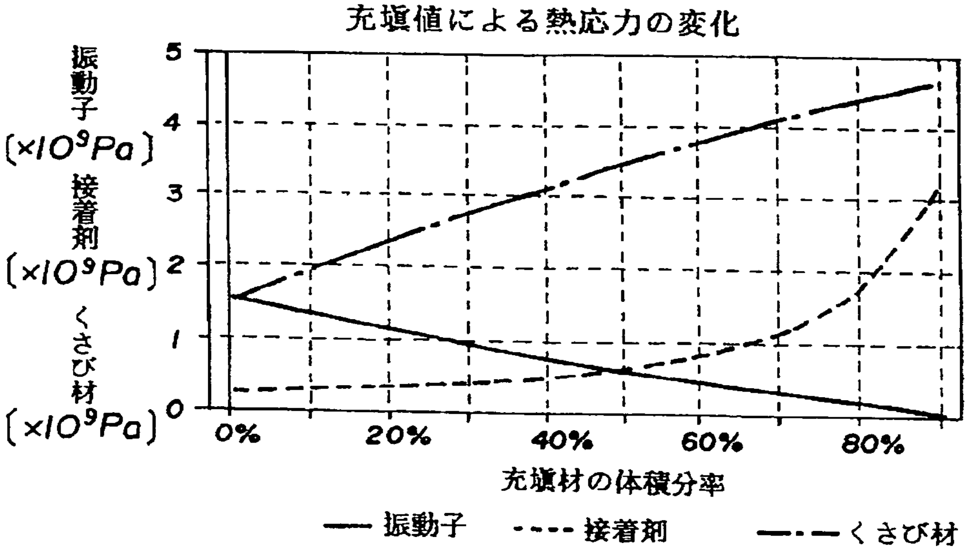
[Drawing 5]



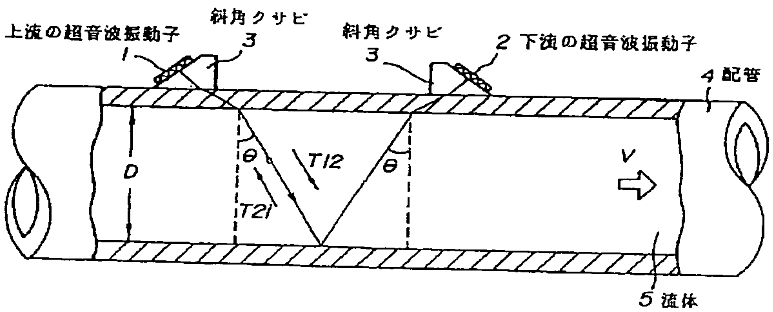
[Drawing 2]



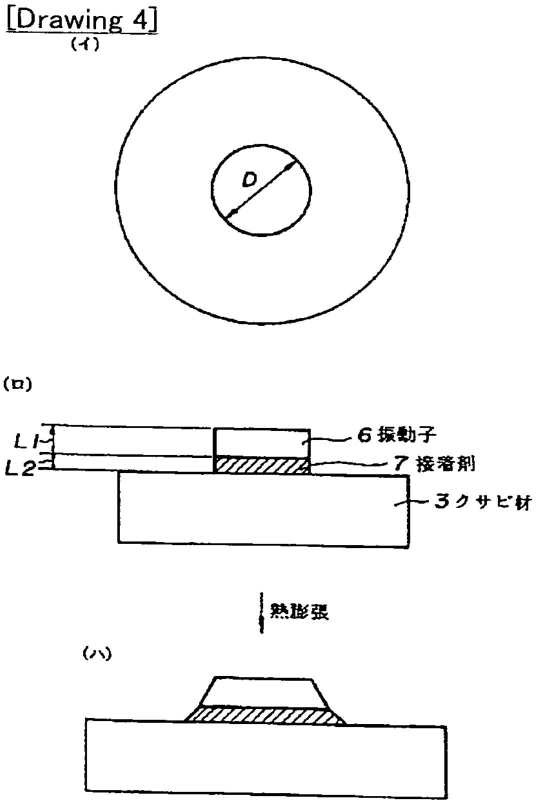
[Drawing 3]



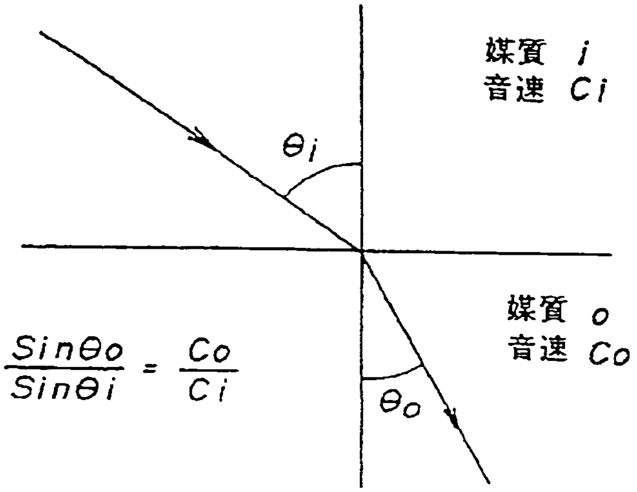
[Drawing 6]



[Drawing 4]



[Drawing 7]



$$\frac{Sin\theta o}{Sin\theta i} = \frac{Co}{Ci}$$

[Translation done.]